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(54) **RAM AIR TURBINE ACTUATOR SYSTEM**

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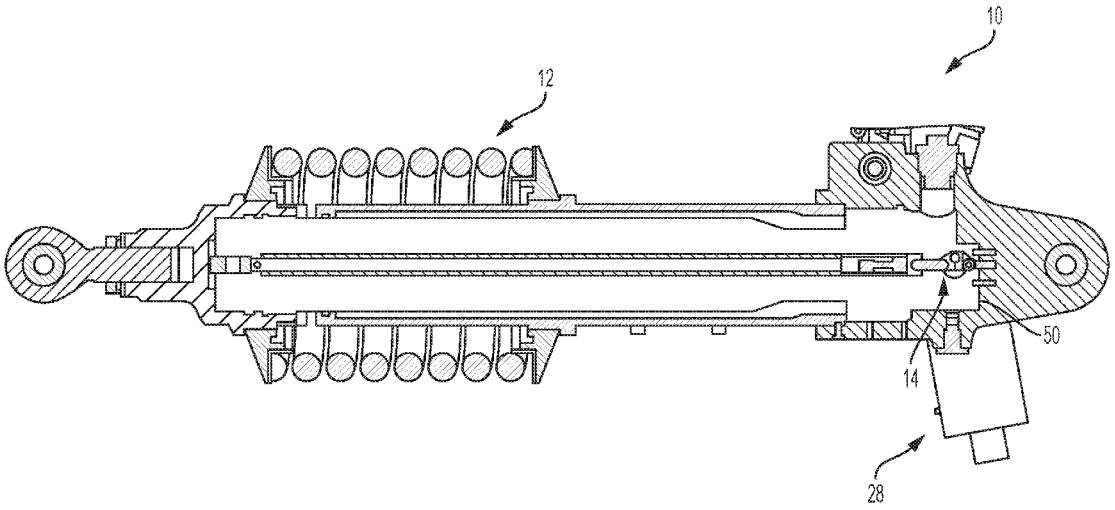
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(57) **ABSTRACT**

A ram air turbine control valve includes a sleeve, a spool, and a return housing. The sleeve defines a first exit port disposed proximate a first end of the sleeve and defines a second exit port disposed between the first exit port and the first end. The spool is radially contained within the sleeve and is movable between a first position and a second position. The return housing is coupled to the first end of the sleeve and defines a cavity that receives a biasing member that engages the spool.



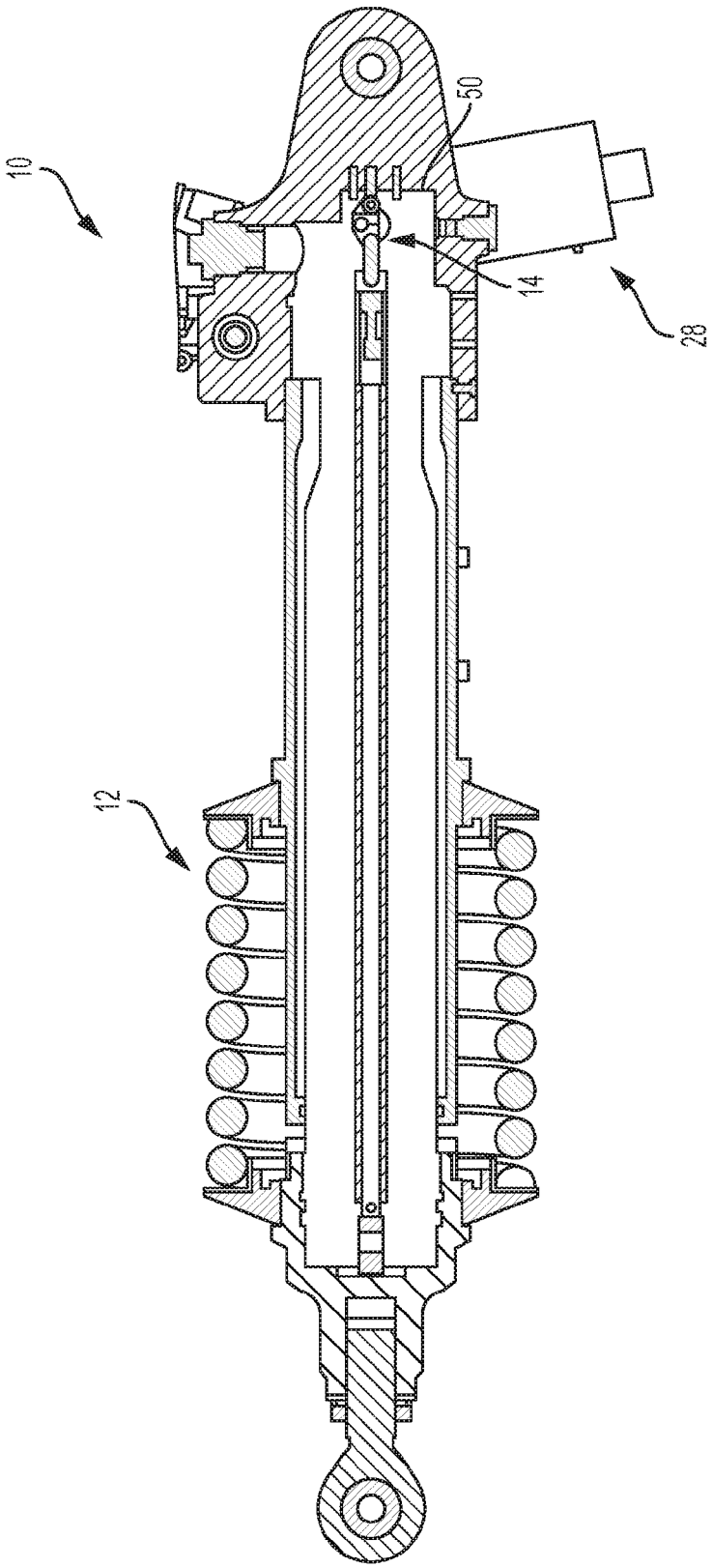


FIG. 1

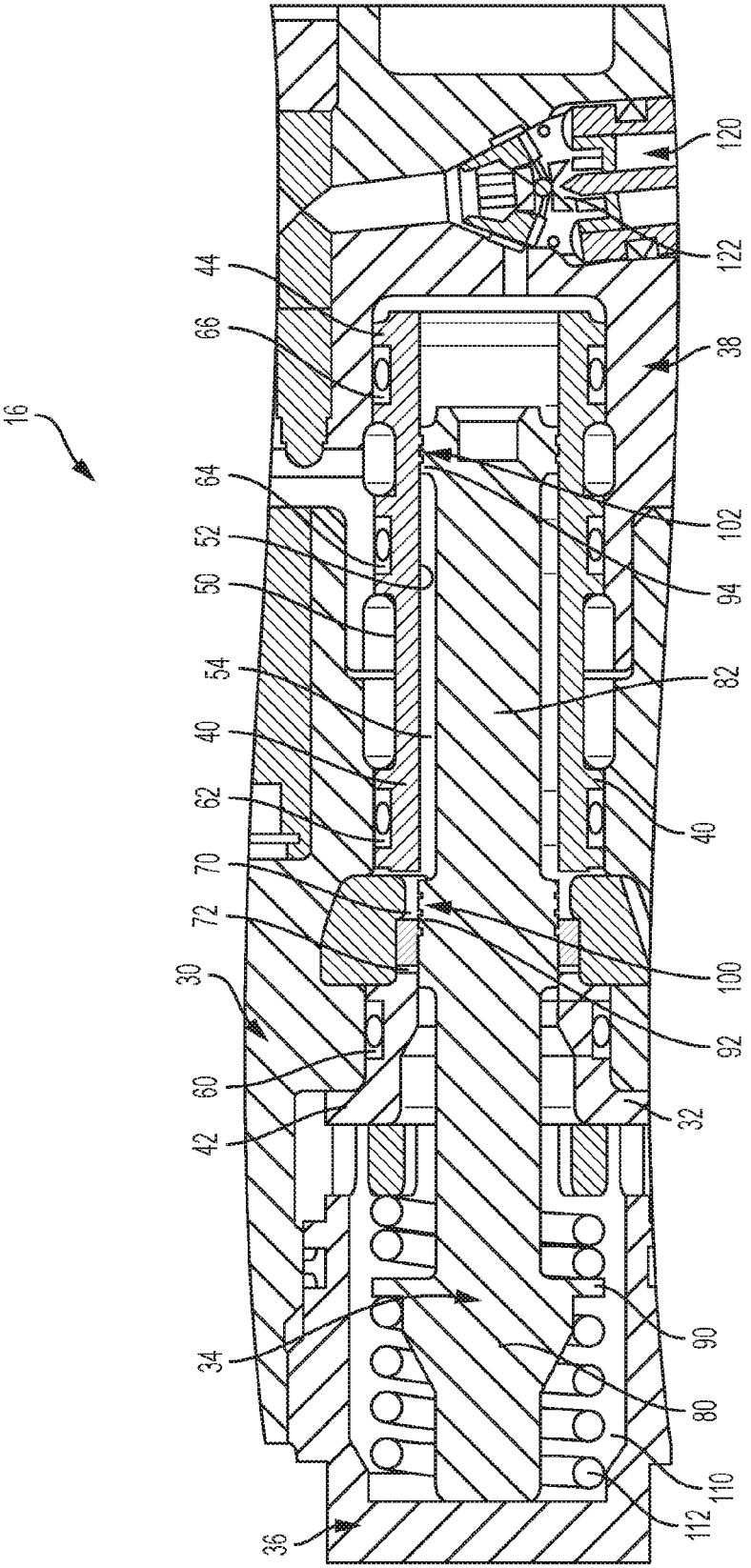

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FIG. 2

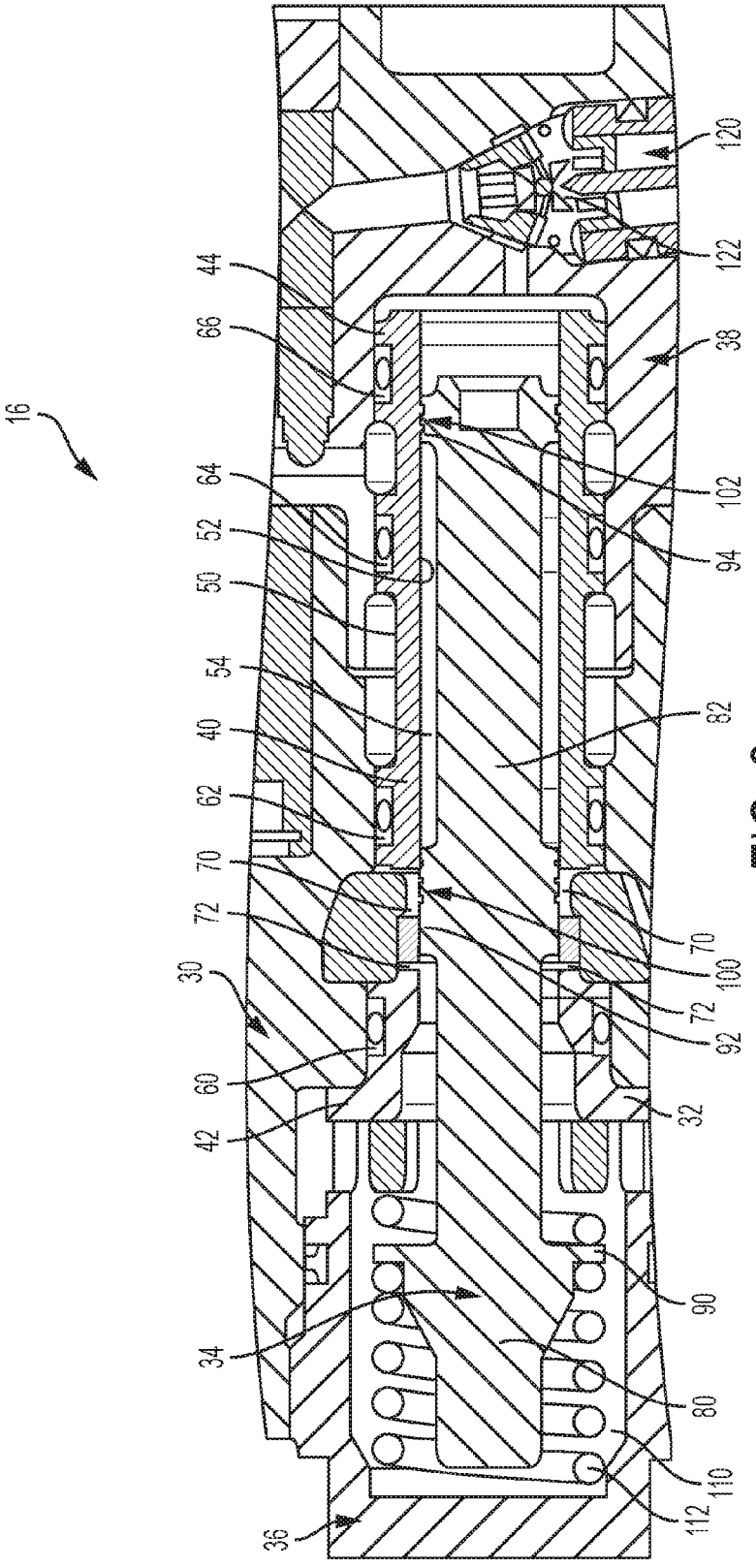

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FIG. 3

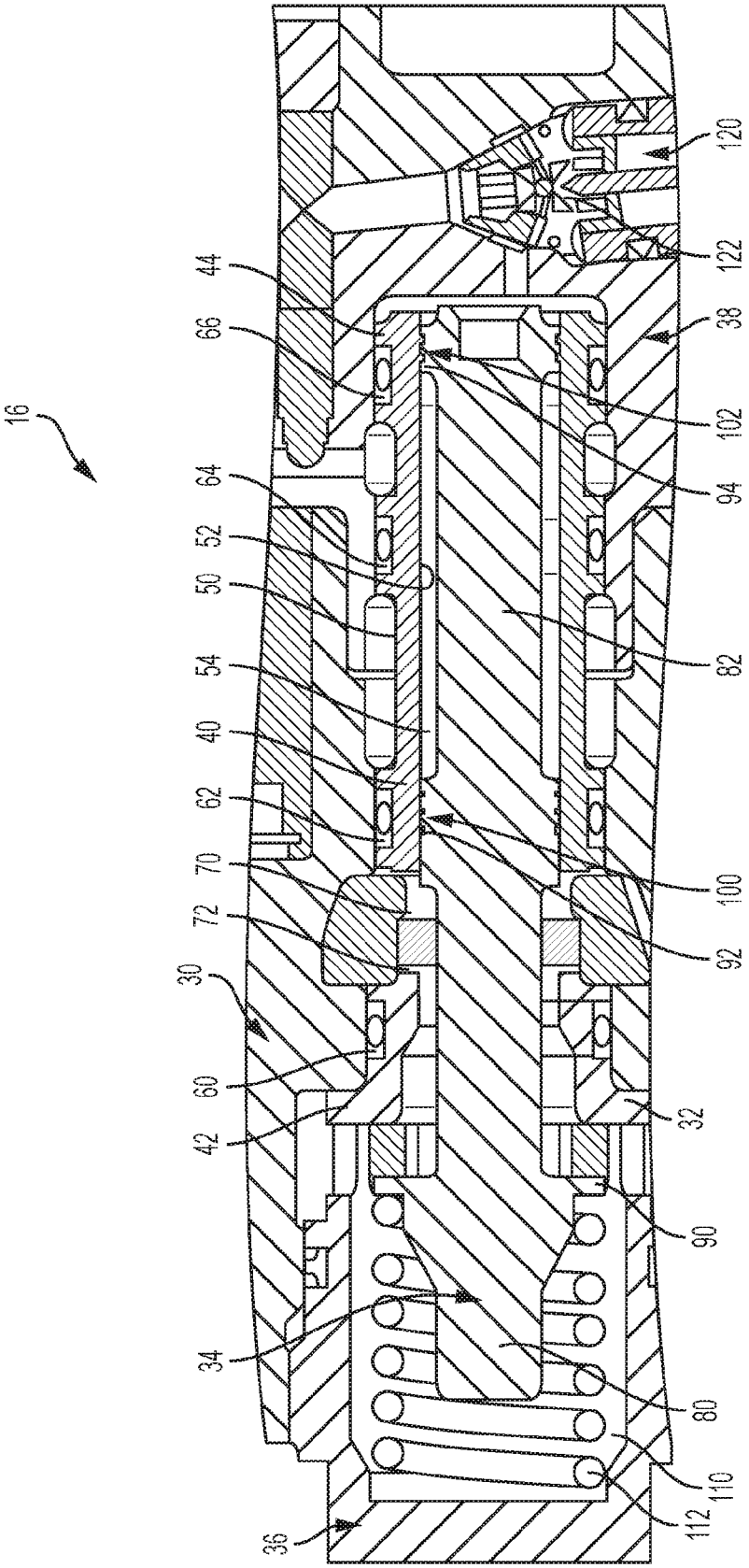

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FIG. 4

RAM AIR TURBINE ACTUATOR SYSTEM

BACKGROUND

[0001] The present disclosure relates to a ram air turbine actuator system having a ram air turbine control valve.

[0002] Some aircraft are provided with a backup power source that may be air driven. The backup power source is sometimes referred to as a ram air turbine and is movable between a stowed position in which the ram air turbine is received within the aircraft fuselage and a deployed position in which the ram air turbine is disposed outside of the aircraft fuselage. The ram air turbine is deployed and/or retracted by a ram air turbine actuator system.

BRIEF DESCRIPTION

[0003] According to an embodiment of the present disclosure, a ram air turbine actuator system is provided. The ram air turbine actuator system includes an actuator assembly and a ram air turbine control valve. The actuator assembly is configured to selectively enable the deployment and retraction of a ram air turbine. The ram air turbine control valve is hydraulically connected to the actuator assembly and includes a sleeve and a spool. The sleeve has a first exit port disposed proximate a first end of the sleeve and has a second exit port disposed between the first exit port and the first end. The spool is radially contained within the sleeve. The spool has a first seal land disposed proximate the first end of the sleeve and had a second seal land disposed proximate a second end of the sleeve.

[0004] According to another embodiment of the present disclosure, a ram air turbine control valve is provided. The ram air turbine control valve includes a sleeve, a spool, and a return housing. The sleeve has a body defining an inner bore. The body extends between a first end and a second end and defines a first exit port disposed proximate the first end and defines a second exit port disposed between the first exit port and the first end. The spool is radially contained within the inner bore and is movable between a first position and a second position. The return housing is coupled to the first end of the sleeve and defines a cavity that receives a biasing member that engages the spool and biases the spool towards the first position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The subject matter which is regarded as the present disclosure is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the present disclosure are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0006] FIG. **1** is a side view of a ram air turbine actuator system;

[0007] FIG. **2** is a side view of a ram air turbine control valve in a first position;

[0008] FIG. **3** is a side view of the ram air turbine actuator valve moving towards a second position; and

[0009] FIG. **4** is a side view of the ram air turbine actuator valve in the second position.

DETAILED DESCRIPTION

[0010] Referring now to the Figures, where the invention will be described with reference to specific embodiments, without limiting same, it is to be understood that the disclosed embodiments are merely illustrative of the invention that may be embodied in various and alternative forms. Various elements of the disclosed embodiments may be combined or omitted to form further embodiments of the invention. The figures are not necessarily to scale; some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for teaching one skilled in the art to variously employ the present invention.

[0011] Throughout this specification, the term "attach," "attachment," "connected", "coupled," "coupling," "mount," or "mounting" shall be interpreted to mean that a structural component or element is in some manner connected to or contacts another element, either directly or indirectly through at least one intervening structural element, or is integrally formed with the other structural element.

[0012] Referring to FIG. **1**, a ram air turbine actuator system **10** is shown. The ram air turbine actuator system **10** is operatively connected to a ram air turbine at a first end and is connected to an aircraft structure at a second end. The ram air turbine is movable between a stowed position and a deployed position by the action of the ram air turbine actuator system **10**. The ram air turbine, when in the deployed position interacts with a moving airstream to provide electrical power or hydraulic power to an aircraft. The ram air turbine, when in the stowed position, does not provide power to the aircraft. The ram air turbine actuator system **10** includes an actuator assembly **12**, a toggle assembly **14**, and a ram air turbine control valve **16** hydraulically or hydraulically connected to the actuator assembly **12**.

[0013] The actuator assembly **12** is configured to selectively move the ram air turbine between the deployed position and the stowed position. During a stowing event, in which the ram air turbine moves from the deployed position towards the stowed position a hydraulic system **20** provides hydraulic pressure to the ram air turbine control valve **16** and ultimately the actuator assembly **12**. The provision of hydraulic pressure to the ram air turbine control valve **16** causes the ram air turbine to begin to and move towards the stowed position within the aircraft. Towards the end of the stowing event, hydraulic pressure is released from the ram air turbine control valve **16**, should the release of the hydraulic pressure not be precisely controlled, the toggle assembly **14** may not remain latched, and the ram air turbine may be inadvertently redeployed. The configuration of the ram air turbine control valve **16** is configured to control the rate of hydraulic pressure release to inhibit inadvertent redeployment of the ram air turbine.

[0014] Referring to FIGS. **2-4**, the ram air turbine control valve **16** includes an actuator housing **30** that receives a sleeve **32**, a spool **34**, a return housing **36**, and a gland housing **38**. The sleeve **32** includes a sleeve body **40** that extends between a first end **42** and a second end **44**. The sleeve body **40** includes an exterior surface **50**, an interior surface **52** disposed opposite the exterior surface **50**, and an inner bore **54** that is defined by the interior surface **52** of the sleeve body **40**.

[0015] The exterior surface **50** defines a first sealing groove **60**, a second sealing groove **62**, a third sealing groove **64**, and a fourth sealing groove **66**. The first sealing

groove **60** is disposed proximate the first end **42** of the sleeve body **40**. The second sealing groove **62** is disposed between the first sealing groove **60** and the third sealing groove **64**. The third sealing groove **64** is disposed between the second sealing groove **62** and the fourth sealing groove **66**. The fourth sealing groove **66** is disposed proximate the second end **44** of the sleeve body **40**. Each sealing groove is configured to receive a sealing member, such as an O-ring, or the like. Each sealing member is configured to engage an inner surface of the actuator housing **30** and a portion of the exterior surface **50**.

[0016] The sleeve body **40** defines a first exit port **70** and a second exit port **72**. The first exit port **70** and the second exit port **72** are hydraulically connected to the hydraulic system **20** and are configured to provide hydraulic pressure to the interior components of the ram air turbine control valve **16**. The first exit port **70** is disposed proximate the first end **42** of the sleeve body **40**. The first exit port **70** extends from the exterior surface **50** to the interior surface **52**. The first exit port **70** is disposed between the first sealing groove **60** and the second sealing groove **62**. The first exit port **70** is disposed closer to the second sealing groove **62** than the first sealing groove **60**. The first exit port **70** has a first exit port diameter.

[0017] The second exit port **72** is spaced apart from the first exit port **70**. The second exit port **72** is disposed between the first exit port **70** and the first end **42** of the sleeve body **40**. The second exit port **72** extends from the exterior surface **50** to the interior surface **52**. The second exit port **72** is disposed between the first sealing groove **60** and the second sealing groove **62**. The second exit port **72** is disposed closer to the first sealing groove **60** than the second sealing groove **62**. The second exit port **72** has a second exit port diameter that is less than the first exit port diameter. The first exit port diameter is greater than the second exit port diameter.

[0018] The spool **34** is radially contained within the sleeve **32**. The spool **34** is received within the inner bore **54** of the sleeve body **40**. The spool **34** is movable between a first position (as shown in FIG. **2**) that corresponds to a position in which the ram air turbine actuator system **10** is stowing or in an energized position and a second position (as shown in FIG. **4**) that corresponds to a dormant position of the ram air turbine actuator system **10** in which the ram air turbine actuator system **10** is stowed, deployed, or deploying. The selective provision of hydraulic pressure from the hydraulic system **20** to the ram air turbine control valve **16** causes the spool **34** to translate between the first position and the second position.

[0019] The spool **34** includes a first spool portion **80** and a second spool portion **82**. The first spool portion **80** extends through the sleeve **32** and is received within the return housing **36**. The first spool portion **80** includes a flange or circumferential rim **90**. The circumferential rim **90** has a diameter that is greater than a diameter of the inner bore **54** of the sleeve body **40** of the sleeve **32**. The circumferential rim **90** is sized such that an end of the first spool portion **80** does not extend into the inner bore **54** of the sleeve body **40** of the sleeve **32** when the spool **34** is moving towards or is in the second position.

[0020] The second spool portion **82** is disposed opposite the first spool portion **80**. The second spool portion **82** defines a first seal land **92** and a second seal land **94**. The first seal land **92** extends from an exterior surface of the second spool portion **82** towards the interior surface **52** of the sleeve body **40**. The first seal land **92** is disposed between a first end of the spool **34** and a second end of the spool **34**. The first seal land **92** defines a first plurality of sealing grooves **100**. The first plurality of sealing grooves **100** extend about a circumference of the first seal land **92**. The first plurality of sealing grooves **100** are configured to aid in establishing a pressure balance between opposite sides of the spool **34**.

[0021] The second seal land **94** is disposed proximate the second end of the spool **34**. The second seal land **94** extends from the exterior surface of the second spool portion **82** towards the interior surface **52** of the sleeve body **40**. The second seal land **94** defines a second plurality of sealing grooves **102**. The second plurality of sealing grooves **102** extend about a circumference of the second seal land **94**. The second plurality of sealing grooves **102** are configured to aid in establishing a pressure balance between opposite sides of the spool **34**.

[0022] The return housing **36** extends into the actuator housing **30**. The return housing **36** is coupled to the first end **42** of the sleeve body **40** of the sleeve **32**. The return housing **36** defines a cavity **110** that receives a biasing member **112**. The biasing member **112** is configured to engage the circumferential rim **90** of the first spool portion **80** of the spool **34**. The biasing member **112** is configured to bias the spool **34** towards the second position.

[0023] The gland housing **38** extends into the actuator housing **30**. The gland housing **38** is coupled to the second end **44** of the sleeve body **40** of the sleeve **32**. The gland housing **38** includes a land **120** having a stow gland assembly **122** that selectively provides hydraulic pressure from the hydraulic system **20** to at least the second end **44** of the sleeve body **40** of the sleeve **32** to move the spool **34** from the second position towards the first position. The stow gland assembly **122** allows for the porting of pressure to shuttle the spool **34**.

[0024] The hydraulic pressure from the stow gland assembly **122** will reach the ram air turbine control valve **16** through a port **74** disposed between the stow gland assembly **122** and the gland housing **38**, proximate the second end **44** of the sleeve body **40**. So between 122 and 38 there is a hole. High hydraulic pressure is supplied through the port **74** and the spool **34** is forced into the first position as shown in FIG. **2**. The moving of the spool **34** moves the ram air turbine control valve **16** to cause the ram air turbine actuator to stow.

[0025] While the spool **34** is in the first position, as shown in FIG. **2**, the first seal land **92** blocks the first exit port **70** and the second exit port **72** to inhibit the exiting of hydraulic pressure from the inner bore **54** of the sleeve **32**. The stow gland assembly **122** seats to block the delivery of hydraulic pressure to the ram air turbine control valve **16** and opens a ram air turbine control valve return, in response to the initiation of a stowing event of the ram air turbine. When the stow gland assembly **122** closes or ceases the provision of hydraulic pressure through port **74**, the hydraulic pressure at the end of the spool **34** proximate the second end **44** of the sleeve body **40** will decrease and will run out through the stow gland assembly **122**. The decrease in the hydraulic pressure causes the biasing member **112** to push against the first spool portion **80** to aid in moving the spool **34** from the position shown in FIG. **2** through the position illustrated in FIG. **3** to the position to FIG. **4**. As the spool **34** moves towards the second position, as shown in FIG. **3**, the first seal land **92** uncovers, exposes, or un-blocks the second exit port

72 to begin releasing hydraulic pressure from the inner bore 54 of the sleeve body 40 of the sleeve 32. The second exit port 72 is exposed prior to the first exit port 70 being exposed. The opening or exposing of the second exit port 72 begins to reduce the hydraulic pressure at a first rate.

[0026] As the spool 34 continues to move towards the second position, as shown in FIG. 4, the first seal land 92 uncovers, exposes, or un-blocks the first exit port 70 to further release hydraulic pressure from the inner bore 54 of the sleeve body. The opening or exposing of the first exit port 70 reduces the hydraulic pressure at a second rate that is greater than the first rate. The opening of the second exit port 72 prior to the first exit port 70 reduces an impact velocity of a lock piston that is associated with the toggle assembly 14. The reduction in the impact velocity of the lock piston that is associated with the toggle assembly 14 decreases the lock piston force to ensure that the toggle assembly 14 remains latched, and the ram air turbine remains stowed.

[0027] While the present disclosure has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the present disclosure is not limited to such disclosed embodiments. Rather, the present disclosure can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the present disclosure. Additionally, while various embodiments of the present disclosure have been described, it is to be understood that aspects of the present disclosure may include only some of the described embodiments. Accordingly, the present disclosure is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

1. A ram air turbine actuator system, comprising:
- a actuator assembly configured to selectively deploy and retract a ram air turbine; and
- a ram air turbine control valve hydraulically connected to the actuator assembly, the ram air turbine control valve comprising:
  - a sleeve having a first exit port disposed proximate a first end of the sleeve and having a second exit port disposed between the first exit port and the first end, and
  - a spool radially contained within the sleeve, the spool having a first seal land disposed proximate the first end of the sleeve and having a second seal land disposed proximate a second end of the sleeve.

2. The ram air turbine actuator system of claim 1, wherein the first seal land defines a first plurality of sealing grooves.

3. The ram air turbine actuator system of claim 2, wherein the second seal land defines a second plurality of sealing grooves.

4. The ram air turbine actuator system of claim 2, wherein the ram air turbine control valve further comprising:
- a return housing coupled to the first end of the sleeve, the return housing defining a cavity that receives a biasing member that engages the spool and biases the spool towards a first position that corresponds to a stowed position of the ram air turbine.

5. The ram air turbine actuator system of claim 4, wherein while the spool is in the first position, the first seal land blocks the first exit port and the second exit port.

6. The ram air turbine actuator system of claim 2, wherein the first exit port has a first exit port diameter and the second exit port has a second exit port diameter.

7. The ram air turbine actuator system of claim 6, wherein the first exit port diameter is greater than the second exit port diameter.

8. A ram air turbine control valve, comprising:
- a sleeve having a body defining an inner bore, the body extending between a first end and a second end, the body defining a first exit port disposed proximate the first end and defining a second exit port disposed between the first exit port and the first end;
- a spool radially contained within the inner bore, the spool movable between a first position and a second position; and
- a return housing coupled to the first end on the sleeve, the return housing defining a cavity that receives a biasing member that engages the spool and biases the spool towards the first position.

9. The ram air turbine control valve of claim 8, wherein the first exit port and the second exit port are disposed between a first sealing groove and a second sealing groove defined by the sleeve.

10. The ram air turbine control valve of claim 8, wherein the first exit port has a first exit port diameter and the second exit port has a second exit port diameter.

11. The ram air turbine control valve of claim 10, wherein the second exit port diameter is less than the first exit port diameter.

12. The ram air turbine control valve of claim 8, wherein the spool includes a first spool portion that engages the biasing member and a second spool portion disposed opposite the first spool portion.

13. The ram air turbine control valve of claim 12, wherein the second spool portion defines a first seal land having a first plurality of grooves.

14. The ram air turbine control valve of claim 13, wherein while the spool is in the first position the first seal land blocks the second exit port and the first exit port.

15. The ram air turbine control valve of claim 14, wherein while the spool moves from the first position towards the second position the second exit port is exposed prior to exposing the first exit port.

16. The ram air turbine control valve of claim 15, wherein the second spool portion defines a second seal land having a second plurality of grooves, the second seal land disposed proximate the second end of the sleeve.

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